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TITLE: Efficient scaling of
non-scalable MPEG-2 Video

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ABSTRACT:

To reduce bandwidth of non-scalable MPEG-2 coded video, certain non-zero AC DCT coefficients for the 8.times.8 blocks are removed from the MPEG-2 coded video. In one implementation, high-frequency AC DCT coefficients are removed at the end of the coefficient scan order. This method requires the least computation and is most desirable if the reduced-bandwidth video is to be spatially sub-sampled. In another implementation,

the smallest-magnitude AC DCT coefficients are removed. This method may produce an undesirable increase in the frequency of occurrence of escape sequences in the (run, level) coding. This frequency can be reduced by retaining certain non-zero AC DCT coefficients that are not the largest magnitude coefficients, and by increasing a quantization scale to reduce the coefficient levels. The reduced-bandwidth video can be used for a variety of applications, such as browsing for search and play-list generation, bit stream scaling for splicing, and bit-rate adjustment for services with limited resources and for multiplexing of transport streams.

21 Claims, 30 Drawing figures

Exemplary Claim Number: 1

Number of Drawing Sheets: 24

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Detailed Description Text - DETX (82):

In order to improve the rate-distortion performance of the scaled-quality MPEG-2 coded video from the FDSNR_LM procedure, the non-zero AC DCT coefficients selected by the FDSNR_LM procedure should be quantized, scanned, and/or (run, level) coded in such a way that tends to reduce the frequency of the escape sequences. For example, if the original-quality MPEG-2 coded video was (run, level) coded using TABLE 0, then the

largest magnitude coefficients should be re-coded using TABLE 1 because TABLE 1 provides shorter length VLCs for some (run, level) combinations having higher run lengths and higher levels. It is also possible that re-coding using the alternate scan method instead of the zig-zag scan method may result in a lower escape sequence frequency of occurrence for escape sequences. For example, each picture could be (run, level) coded for both zig-zag scanning and alternate scanning, and the scanning method providing the fewest escape sequences, or the least number of bits total, could be selected for the coding of the reduced-quality coded MPEG video.

Claims Text - CLTX (1):

1. A method of scaling non-scalable MPEG-2 coded video to produce reduced-bandwidth, reduced-quality MPEG-2 coded video, the non-scalable MPEG-2 coded video including a set of non-zero AC discrete cosine transform (DCT) coefficients for 8.times.8 blocks of the non-scalable MPEG-2 coded video, said method including the step of removing non-zero AC DCT coefficients from the non-scalable MPEG-2 coded video so that there are no more than a selected number of non-zero AC DCT coefficients in the reduced-quality MPEG-2 coded video for each of the 8.times.8 blocks, which includes inspecting magnitudes of the non-zero AC DCT coefficients to sort at least some of the non-zero AC DCT coefficients in each 8.times.8 block in terms of magnitude for retaining up to

the selected number of largest magnitude non-zero AC DCT coefficients for said each 8.times.8 block, and removing any additional non-zero AC DCT coefficients for said each 8.times.8 block.

Claims Text - CLTX (5):

5. A method of scaling non-scalable MPEG-2 coded video to produce reduced-bandwidth, reduced-quality MPEG-2 coded video, the non-scalable MPEG-2 coded video including a set of non-zero AC discrete cosine transform (DCT) coefficients for 8.times.8 blocks of the non-scalable MPEG-2 coded video, said method including the step of removing non-zero AC DCT coefficients from the non-scalable MPEG-2 coded video so that there are no more than a selected number of non-zero AC DCT coefficients in the reduced-quality MPEG-2 coded video for each of the 8.times.8 blocks, which includes inspecting magnitudes of the non-zero AC DCT coefficients to order at least some of the non-zero AC DCT coefficients in each 8.times.8 block in terms of magnitude for retaining up to the selected number of the non-zero AC DCT coefficients for said each 8.times.8 block that differ in magnitude from up to the selected number of largest magnitude non-zero AC DCT coefficients for said each 8.times.8 block by no more than a certain limit.

Claims Text - CLTX (9):

9. A method of scaling non-scalable MPEG-2 coded video to produce

reduced-bandwidth, reduced-quality MPEG-2 coded video, the non-scalable MPEG-2 coded video including a set of non-zero AC discrete cosine transform (DCT) coefficients for 8.times.8 blocks of the non-scalable MPEG-2 coded video, said method including the step of removing non-zero AC DCT coefficients from the non-zero AC DCT coefficients of the non-scalable MPEG-2 coded video so that there are no more than a selected number of non-zero AC DCT coefficients in the reduced-quality MPEG-2 coded video for each of the 8.times.8 blocks, and which further includes selecting an initial set of the non-zero AC DCT coefficients to include in the reduced-quality MPEG-2 coded video, (run, level) coding the initial set of the non-zero AC DCT coefficients, and upon finding an escape sequence in the (run, level) coding of the initial set of the non-zero AC DCT coefficients, searching for a non-zero AC DCT coefficient of the non-scalable MPEG-2 coded video that is not in the initial set of the non-zero AC DCT coefficients and that would eliminate the escape sequence when included in the reduced-quality MPEG-2 coded video, and upon finding such a non-zero AC DCT coefficient of the non-scalable MPEG-2 coded video, including such a non-zero AC DCT coefficient in the reduced-quality MPEG-2 coded video.

Claims Text - CLTX (12):

12. The method as claimed in claim 9, which further includes increasing a quantization scale for the reduced-quality MPEG-2 coded video in order to

reduce levels of the non-zero AC coefficients retained in the reduced-quality MPEG-2 coded video.

Claims Text - CLTX (16):

16. A method of scaling non-scalable MPEG-2 coded video to produce reduced-bandwidth, reduced-quality MPEG-2 coded video, the non-scalable MPEG-2 coded video including a set of non-zero AC discrete cosine transform (DCT) coefficients for 8.times.8 blocks of the non-scalable MPEG-2 coded video, said method including the step of removing non-zero AC DCT coefficients from the non-scalable MPEG-2 coded video by selecting an initial set of the non-zero AC DCT coefficients to include in the reduced-quality MPEG-2 coded video, (run, level) coding the initial set of the non-zero AC DCT coefficients, and upon finding an escape sequence in the (run, level) coding of the initial set of the non-zero AC DCT coefficients, searching for a non-zero AC DCT coefficient of the non-scalable MPEG-2 coded video that is not in the initial set of the non-zero AC DCT coefficients and that would eliminate the escape sequence when included in the reduced-quality MPEG-2 coded video, and upon finding such a non-zero AC DCT coefficient of the non-scalable MPEG-2 coded video, including such a non-zero AC DCT coefficient in the reduced-quality MPEG-2 coded video.

Claims Text - CLTX (19):

19. The method as claimed in claim 16, which

further includes increasing a quantization scale for the reduced-quality MPEG-2 coded video in order to reduce levels of the non-zero AC coefficients retained in the reduced-quality MPEG-2 coded video.